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THE CORRECT

PRINCIPLES OF TREATMENT

FOR

ANGULAR CURVATURE

OF

THE SPINE.

BY

BENJAMIN LEE, A.M., M.D.

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PREFACE.

THE little volume entitled "Contributions to the Diagnosis, Pathology, and Treatment of Angular Curvature of the Spine," which I had the honor to lay before the profession a few years since, has been for some time out of print. In the meantime our knowledge of this affection and our means of treating it have not made such advances as to render the doctrines then advanced obsolete on the one hand, nor, on the other, has the great body of practicing physicians become so familiar with them as to make their repetition unnecessary. It has occurred to me, however, that the information which appears to be called for by the frequent inquiries addressed me by members of the profession, in regard to the subject, might be placed within still smaller compass, omitting much that was merely argumentative or indirectly personal. I have, therefore, determined to reproduce only that one of the former collection of papers which was devoted to the consideration of the

principles on which the disease can be most successfully combated and the means for their practical application, supplementing it with a more complete and minute explanation of one of the modes of treatment there alluded to, in the shape of a clinical lecture since delivered before the Medical Society of the State of Pennsylvania.

I confess, not unwillingly, that I find myself able to improve in not the slightest degree on the principles unfolded in the first essay, and to but a very trifling extent on the details of their material embodiment. A constantly widening field of experience and observation only confirms me in my adherence to the conclusions then reached: *first*, that an *early recognition* of the disease will in a great number of cases enable us to arrest it *before deformity has been produced*; *secondly*, that *mechanical treatment* is of vastly greater importance than medication; and *thirdly*, that *the form of mechanical treatment* which gives by far the most uniformly satisfactory results is that of *constant antero-posterior support* by portable instruments,—assisted by *occasional modified suspension* by means of fixed apparatus.

A recent English writer well speaks of the “sterling value of an early, accurate diagnosis” in

this affection. In the humble hope of assisting the busy practitioner in the attainment of this most desirable end, I have appended a table which will indicate at a glance the diseases with which angular curvature is most frequently confounded in its initial stage.

Especial attention is invited to the fact (which is presented with the utmost confidence) that pain and tenderness in the back, which are described as early symptoms in all the systematic works on surgery, are almost never present,—the first manifestation of the existence of the disease being pain on the anterior aspect of the trunk.

1503 SPRUCE STREET, PHILADELPHIA,

April 26, 1872.

I.

ANTERO-POSTERIOR SUPPORT.

Recommended for publication by the Committee on Prize Essays of the American Medical Association, the accidental disclosure of the author's name having excluded it from competition.

Extracted from the Transactions of the Association for 1866.

I.

ANTERO-POSTERIOR SUPPORT.

THE principles upon which angular curvature, or ulcerative inflammation of the spinal column, is to be treated, are threefold :

1st. PATHOLOGICAL—Dependent upon the nature and seat of the disease.

2d. MECHANICAL—Following necessarily from the laws of physical science, and

3d. ANATOMICAL—Growing out of the conformation of the vertebræ and their mutual relations.

Each of these principles has so direct, logical, and essential a bearing on the other two, that they need but to be placed side by side in order to crystallize into an argument. Any attempt to ameliorate the disease in ignorance or neglect of these cardinal points, and of their relative interdependence, must fall very far short of that happy result which is, in most cases, attainable by pursuing a plan of treatment strictly based upon them.

First, then, we consider the *Pathological* element of the problem.

The essential lesion of this affection is ulcerative inflammation or caries of the bodies of one or more vertebræ, or an analogous condition of one or more of the intervertebral substances, or both combined. This condition of the intervertebral substances is called "disintegration" or "softening," though it is difficult to conceive of a reason why the expression, ulcerative inflammation, is not applicable here also. The disease may commence in either situation. Dr. Bauer, of Brooklyn, relates a case* in which the autopsy revealed advanced degeneration of cartilages which were remote from the carious vertebræ, while the diseased action in the vertebræ affected had evidently progressed from the surface towards the centre. The progress and form of the curve, in many instances, seem to indicate these portions of the column as the sole seat of disease. (Writers who deny the occasional origin of the inflammatory action in these substances on the ground of their cartilaginous nature, forget that they are not simple cartilage, but *fibro*-cartilage, in which the fibrous element largely predominates.) Not only this—they ignore the researches of one of the most distinguished of modern pathological anatomists. When Rokitsky pronounces the deposit found in

* Lectures on Orthopædic Surgery, p. 67.

a carious vertebra to be tuberculous, he is simply expressing an opinion as to the nature of this deposit, from which any physician, in the present state of our knowledge of this pathological element, has a right to dissent. But when he states that inflammation sometimes commences in the intervertebral substances and extends from them to the contiguous vertebræ, he is announcing a fact which he has the means of verifying, and which cannot be overthrown by the exhibition of any number of merely negative dried specimens on the shelves of a museum. That he does state this most unequivocally is apparent from the two following quotations. Treating of inflammation of the vertebræ, he says: * "It is very commonly the primary disease, but sometimes it is brought on by previous inflammation and suppuration of the ligamentous apparatus of the column and of the *intervertebral substance*." Again, speaking of inflammation of fibro-cartilages, he makes the following assertion: † "An inflammation is sometimes met with in the intervertebral cartilages which terminates sooner or later in suppuration, and is generally, in the end, combined with inflammation and caries of the bodies of the vertebræ." So careful a writer and close an observer would scarcely hazard a positive assertion

* Manual of Pathological Anatomy, vol. iii. p. 192.

† Ibid., p. 215.

of this kind, had he not actually seen that which he describes.

Mr. Bampfield says unhesitatingly*: "*Dissections prove* that the most dangerous and fatal consequences ensue from inflammation of the intervertebral substance, terminating in its ulceration, which brings in its train caries of the surfaces of the vertebræ to which it is attached;" and, further on: † "I am induced to believe, from appearances on dissection, that the inflammation *primarily* attacks the intervertebral substance in the *generality* of cases of angular projection." Mr. Copeland ‡ and Sir Benjamin Brodie § both advance the opinion that certain cases originate in intervertebral inflammation, which has always, in their belief, a strong tendency to ulceration.

This point, however, has not so material a bearing upon the treatment as the question of the simple or tubercular nature of the destructive action. Of course, if we admit the presence of a foreign and noxious deposit in the structure of the bone as the exciting and promoting cause of the destructive inflammation, we at once strike at the root of all mechanical treatment, whether this consist in the wearisome confinement to the prone or

* An Essay on Curvatures and Diseases of the Spine, p. 150.

† Loc. cit.

‡ Copeland on the Spine, p. 42.

§ Brodie on the Joints, p. 170.

supine posture, or in the employment of instrumental support. Among the standard authorities, I find that Erichsen,* while prefacing his article on this subject by stating his belief that this "affection consists essentially in tubercular infiltration of the bodies of the vertebræ," makes subsequently the following admission: "It must not, however, be supposed, that abscess necessarily forms in all cases; indeed, the formation of matter will, I believe, chiefly depend upon whether the disease of the vertebræ be tuberculous or not. *Simple congestive* or *inflammatory caries* of the spine may take place to a very considerable extent, and yet no suppuration occur, the bodies of the vertebræ undergoing erosion and absorption, and coalescing so as to become fused together into one soft and friable mass of bone, across which bridges of osseous tissue are sometimes thrown out, so as to strengthen the otherwise weakened spine. In these cases, masses of porcelaneous deposit will not unfrequently be found intermixed with and adherent to the carious bone. Indeed, this ankylosis and fusion of the bodies of the diseased vertebræ may be looked upon as a natural mode of cure of angular curvature of the spine, the only way in which it can take place, when it has advanced to any considerable extent."

The evident meaning of this passage is, that

* Science and Art of Surgery, p. 640.

only those cases are tubercular which develop abscess, and that these cases are generally fatal. Now, as a large proportion of cases terminate in ankylosis and spontaneous recovery, with a degree of deformity varying with the character of the mechanical treatment, it follows that just such proportion of cases are those of simple caries. Quotations might be multiplied to show that the once universal belief in the necessarily tuberculous nature of this disease by no means receives the general assent of the thinking portion of the profession to-day. Mr. Barwell, whose work is now a classic, says, in discussing bone tubercle generally:* “Tuberculous deposit in bone is, I believe, very rare; when it does occur, it is a *result* and *not a cause* of osteitis. . . . Many an old and desiccated purulent deposit in bone has been mistaken for tubercle; the position in spongy bone which favors pressure, the assumption therefore of a peculiar form by the dried concretion, and the fact that such pus consists of broken-down and disintegrated cells with granules, etc., render the distinction extremely difficult. I must confess that I could accept no case as undoubted tuberculosis of bone unless some of the deposit was in a state of crudity. It must be remembered that when we find tubercles in other organs, even though most of

* Treatise on Diseases of the Joints, p. 231.

the material may be in the furthest advanced stage of softening, some will very nearly always be crude ; but I am not aware of any observations of crude tubercles in bone."

(That the disease occurs oftener in those whose nutrition is enfeebled or depraved, as the result alike of hereditary vice of constitution, of exposure, or of deficient or improper alimentation, no one will deny ; but the converse of this proposition, viz., that it may arise in those whose systems are entirely free from taint, original or acquired, as simply the result of local injury, I am fully prepared to maintain.)

The portion of the vertebra which is most frequently attacked by the disease has a very direct bearing upon the treatment. (All authorities agree in telling us that its usual seat is the body of the vertebra and the intervertebral cartilage, the pedicles and the processes rarely being affected.) Now, a moment's reflection suffices to show that, in those cases where there is posterior projection, the *anterior* portion of the bodies must be destroyed to a greater or less extent ; for it is impossible for such a projection to take place as long as the anterior surfaces of contact are integral. But posterior angular curvature does take place, in by far the greater number of cases, at a very early stage of the disease, so much so that it has given the name to the affection. Hence the conclusion is obvious that the anterior portion of the bodies of the vertebræ

or of the intervertebral substances is the most frequent point of invasion. There are two sufficient reasons why the bodies should be affected oftener than the processes: First, because they are composed almost entirely of soft, spongy, reticulated bone, well supplied with blood-vessels, which is, in all parts of the frame, more subject to congestion, inflammation, and ulceration than the compact osseous tissue, of which the pedicles are almost entirely, and the processes to a considerably greater degree than the bodies, composed. The pedicles thus form an almost insuperable obstacle to the direct advance of the disease from the bodies to the oblique processes. Secondly, because it is on this portion of the spinal column that the entire weight of the trunk, head, and upper extremities is sustained, and hence on it must fall all vertical shock and concussion. The oblique processes, it is true, act to some extent as decomposers of shock, especially when it occurs somewhat out of the strictly vertical direction, but owing to the oblique adaptation of their articulating surfaces, and the fact that they admit of a slight degree of motion upon each other, they rarely suffer serious injury from this cause. The contiguity of the viscera of the abdomen and chest, and of those extremely vascular membranes, the peritoneum and pleura, may suggest a reason why the anterior portion should be more frequently attacked than the posterior; although the preponderance

of the body anteriorly, producing increased pressure in that region of the column, might in itself be considered a sufficient cause.)

Secondly, the *Mechanical Element* becomes of consequence from the deformity to which the disease gives rise.

(The natural support of the head and trunk failing, we must supplement it by means of artificial support. Not, it is true, with the object of removing the deformity,—although that result may sometimes be incidentally attained in the prosecution of the main design,—but with a view to the relief of the irritation produced by the constant and severe pressure at the seat of disease, which pressure is the main obstacle to a natural process of healing. This pressure can only be relieved by diminishing the abnormal curvature, by placing the column in a position more nearly approximating its natural curves, and maintaining it constantly in that position. The mechanical problem, then, is simply, as far as may be possible, to *straighten out the curved spine.*)

The true method of applying force to restore a curved spine to its normal direction was first distinctly enunciated, so far as I am able to discover, by Mr. Lonsdale, in the preface to his work entitled *Observations on the Treatment of Lateral Curvature of the Spine*, published in the year 1847, and although he had in view simply the variety of curvature of which he was treating, the principle

applies with even greater aptness to the angular deviation in consequence of the anatomical peculiarities which I shall presently point out. "It appears to me," he writes on page v of the preface, "that the principle of extension is not the best to act upon to bring the spine from the curved into the straight position; nor do I think it the most scientific, for the force tells mechanically with the least advantage, and requires that most powerful means be exerted to produce the desired effect. All curves, no matter of what nature the body in which they exist, are more easily rectified by applying the force in an opposite direction, by *unbending* them rather than by pulling upon them at their two extremities; in the former the advantage of a lever power is gained, in the latter an extending force only can be employed, at the same time that it tells in the least favorable direction. This principle is equally applicable to curvature of the spine where the vertebral column has been bent or thrown out of its natural erect line by mechanical causes only. The spine, though composed of many small bones, is similarly circumstanced to a single long bone, that may yield or become curved from its structure being too weak to resist any mechanical weight it may have to support, or that may be made to tell against it. The effect produced is the same in both cases, though the causes are not precisely similar. Taking this view of the subject, it appears to me that the

treatment of a curvature of the spine, depending on simple weakness, unaccompanied with disease of the bones or ligaments, should be conducted upon the same principles as when the curvature exists in a single bone only."

Lonsdale was deterred, as we see, from applying the principle he thus clearly enunciates to the case of angular curvature by the fear of injury to the diseased vertebræ, owing to a failure to appreciate the precise pathologico-anatomical conditions, and all subsequent English writers seem to have shared his apprehensions, for we find Mr. Heather Bigg, "Anatomical Mechanist to the Queen," etc., in a treatise on what he styles *Orthopraxy*, just issued from the press of John Churchill, London, after describing an instrument for making pressure against the dorsal curve, in cases of posterior curvature dependent on mere debility, saying of Pott's disease, that "any attempt to make the same amount of pressure below the axis of curvature would here lead to most disastrous results."*

Fortunately, American medical science is pretty well out of the leading-strings of its European nurses, and dares to think for itself. The problem was now fairly before it in both its equations: the *Pathological*, the nature and seat of the disease, with the resultant deformity; the *Mechanical*, the

* *Orthopraxy: the Mechanical Treatment of Deformities, Debilities and Deficiencies of the Human Frame*, p. 245.

true method of employing force in accordance with the laws of physics, in order to unbend the curve.

Anatomy furnished the key to its solution, and it was grasped by an American physician. Dr. H. G. Davis, of New York, whose suggestions on this subject, as well as in relation to the treatment of the cognate affection, disease of the hip-joint, have laid the profession and humanity under a lasting debt of gratitude, published a paper in the *American Medical Monthly* for March, 1856, entitled "Deformities and their Remedy." In the course of this article, he holds the following language: "The common mode of constructing apparatus to sustain the weight of the body on crutches is entirely useless, as the crutch impinges directly against the bundle of nerves and blood-vessels that meet in the axilla, upon which the weight of the arm cannot even be borne, much less that of any additional portion of the body. I think, however, that this difficulty has been seen by surgeons, but there was not found any other point where support could be applied. It was rather a choice between two evils, that of no support, or in this way." In a continuation of the same article in a subsequent number of the *Monthly*, he enunciates, as I believe, for the first time, the true principles of treatment for "Angular Curvature," as follows: "As the treatment of angular distortion of the spine, the result of ulceration of the vertebræ, is

mechanical, so far as restoring or retaining the figure erect, it will be advisable to examine cursorily the form and points of support of the vertebræ, as involved in this kind of surgical treatment. As far as our purpose is concerned, it will be necessary only to mention the body (the seat of the disease usually), the oblique and the spinous processes.

“The body and the oblique processes afford the only perpendicular support; the distortion is produced by the removal of the body of the vertebræ by ulceration. As the line of perpendicular support falls between the body and the articulation of the oblique processes, the weight of the trunk above approximates the bodies of the two adjoining vertebræ, as the diseased one is removed by absorption; the oblique processes, now sustaining the greater part of the weight, act as fulcrums upon which the vertebræ are tilted or rotated; thus the spinous processes above and below are separated from that of the diseased one, the articulation of the oblique processes being the centre of motion.

“It is this form of the vertebræ which enables us to make use of the whole column as a lever to restore it. By apparatus we are enabled to throw the entire weight of the superincumbent body upon the oblique processes, and separate the bodies adjoining the diseased one from it, the contact of which was constantly irritating and producing ab-

sorption. By this mechanical arrangement the spinal line is brought into its natural position. This replacement is advantageous, not only by restoring the figure, but, by the removing of all mechanical irritation and pressure, it, in many cases, stops the disease at the same time; the process of reparation commences upon the application of the apparatus. The apparatus should confine the parts quite immovably in their normal position, and retain them there until recovery has taken place. Thus supported, I have seen a large majority of cases restored without the use of any constitutional treatment, with the exception of air, diet, and exercise. As the ulceration seldom extends to the oblique processes, we are always enabled to use them to sustain the weight of the body above."

Thus, we have the demonstration complete: *Pathological Anatomy* shows us an intervertebral cartilage in a condition of congestion or softening, yielding to the pressure from above; the body of an inflamed or ulcerated vertebra crumbling anteriorly under the superimposed weight of the head, trunk, and upper extremities, and thus producing a posterior projection of the spinal column. *Mechanics* indicates the true method of redressing this distortion, and thus relieving the pressure, provided the necessary conditions are present for applying the force; and *Physiological Anatomy*, scientifically interpreted, triumphantly steps in to

point out the oblique processes, happily protected from the ravages of disease, as the precise means desired. More fortunate than Archimedes, we have found our fulcrum. A world of suffering and disease may now be moved. I say a world of suffering; and that I use the expression advisedly, let an English writer testify. Mr. Bampfield, in his essay already alluded to, says:* “When the perversion of the natural situations of the viscera, of the great blood-vessels, of the ganglionic system of nerves, and of the thoracic duct, is contemplated; when the structural alterations and deviations of the lungs, heart, liver, and some other of the viscera, aorta descendens, venæ cavæ, thoracic duct, and some of the nerves, are considered; when the derangements of the spinal cord and the spinal nerves, of the abdominal and intercostal muscles, and diaphragm, and the curved and shortened spine, are weighed; when we view the spinal marrow, thus deranged, as the principal source of sensation and motion, and know the spinal nerves are distributed to all the viscera contained within the thorax, abdomen, and pelvis, and supply them with the nervous energy necessary to their important functions, as well as to the muscles of the upper and lower extremities, back, chest, diaphragm, and all the other constituent parts, besides possessing a connection with the nerves of the brain through

* *Op. cit.*, p. 40.

the ramifications of the great sympathetic; when we reflect on the aggregate of disorder and displacement of the framework and the frame, we cannot be astonished at hearing an appalling catalogue of maladies which are attendants or consequences of spinal deformity and disease,—a catalogue whose history and treatment to pursue and dwell upon in this dissertation, would make it almost endless, for I have known the head affected with severe pain, occasionally predisposing to *phrenitis* and death; the eyes affected with convulsions and imperfect vision; the ears with deficient hearing; and I have witnessed as companions to curvatures of the spine, dyspnœa, asthma, congestion and inflammation of the lungs; imperfect oxygenation of the blood; palpitation of the heart; aneurisms of the aorta; a corded tightness across the epigastre; gastrodynia; indigestion; loss of appetite, or a vitiated state of it; torpor of the liver, or deficient secretion of the bile; constipation; discolored feces; morbid secretions of the kidneys, involuntary discharge of urine and feces; a variety of nervous feelings; epileptic fits; numbness and coldness of the extremities; *tic-douloureux-like* pains about the joints of the lower extremities and muscles, and of the posterior part of the *ilium*, paralysis of the upper and lower extremities, and an almost universal torpor." An appalling catalogue, truly, and yet for its correctness I can myself vouch in almost every particular,

allowance being made for modern alterations in the nomenclature of disease.

Fig. 1.

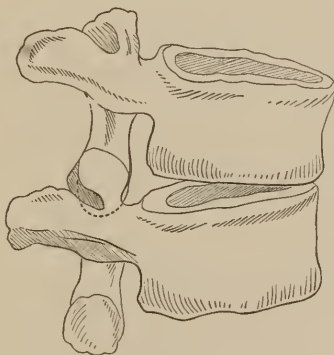


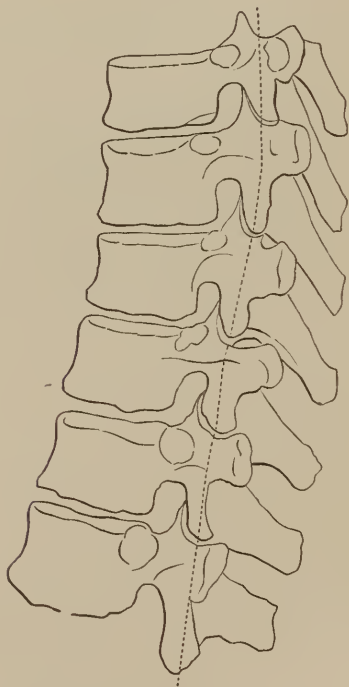
Fig. 2.



But to return to our demonstration. The accompanying illustrations indicate the manner in which

the oblique processes may be made to take the place of the bodies as the supporting column of the trunk. Figs. 1 and 2 are taken from an American reproduction of the anatomical plates of Bour-

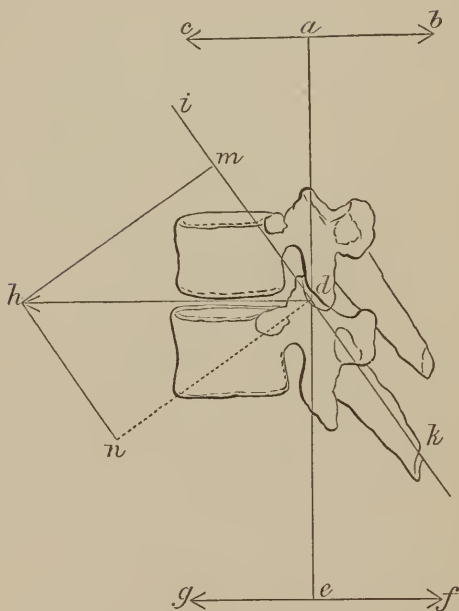
Fig. 3.



gery and Jacob. The bodies of two lumbar vertebrae are here represented with the processes of the left side only. In Fig. 1 their position is such as

would result from partial destruction of the intervertebral substance anteriorly, permitting the opposing surfaces of the bodies to come in contact. In Fig. 2 they are maintained nearly in their natural position, the support being through the oblique processes. Fig. 3, from Richardson's *Human Anatomy*, gives a lateral view of six inferior dorsal vertebræ; a dotted line shows the new column of support. The oblique direction of the planes of articulation of the oblique processes, well shown in this illustration, makes them more available as points of leverage for our antero-posterior force than if they presented the horizontal plane of the articulations of the bodies. This will be understood by reference to the accompanying diagram (Fig. 4). Let the horizontal lines *ab* and *ef* represent the forces exerted by an instrument at the extremities of the spinal column. On the principle that action and reaction are equal, the resistances to these forces will be represented by *ac* and *eg*, respectively, and the resultant of these resistances will be *dh*, acting at the centre of the articulation of two oblique processes. But its direction relatively to the plane of this articulation being oblique, it may be decomposed into two forces, *hm* and *hn*, of which *hn* only will exercise any force of displacement. The strain on the ligaments is thus very materially lessened, while, at the same time, the surfaces of contact are nearly doubled.

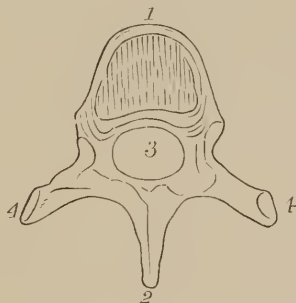
Fig. 4.



Being thus provided with a satisfactory fulcrum for our spinal levers, it is evident that our instrumental levers, which are to act upon them, must have their point of action at the same relative position. In other words, that pressure must be made against the curve at, or just below, its apex. But here we are met with the practical difficulty, that the integument immediately covering the projecting spinous processes is too delicate to admit of

any pressure sufficient to accomplish our object. Can we avoid pressure upon these spinous processes, and still meet the indication? Anatomy again helps us to a solution. In Fig. 5 we have the upper surface of a dorsal vertebra; (1) being

Fig. 5.



the body, (2) the spinous process, (3) the foramen for the passage of the spinal cord, and (4) the transverse processes. These latter, it will be noticed, project laterally far beyond the body of the vertebra, and being, moreover, protected by a thick cushion of muscles, which fills up all the interspace between them and the spinous process, afford an admirable surface of resistance on either side, leaving ample room for the spine to project between.

Having thus established our principles of treatment on a rational and scientific basis, it only re-

mains to indicate the best means of applying them. I am not aware that Dr. Davis has published any description of the apparatus which he makes use of to carry out the theory he originated.

The instrument which I am in the habit of employing, and with the results of which I have every reason to feel satisfied, was first introduced to the notice of the profession at large at the session of the Medical Society of the State of New York, in 1863, by Dr. Charles F. Taylor, of New York City, in a paper entitled the "Mechanical Treatment of Angular Curvature, or Pott's Disease of the Spine."

It is proper to remark, however, that Dr. Taylor had been, for several years previous to the publication of this article, engaged in perfecting his invention, and that most of the leading practitioners of New York were already familiar with his treatment. I give the description of the instrument, principally in his own words, introducing my own remarks in parentheses :

"A broad band passes around the trunk low down, so low that in front it almost touches the thighs in sitting. It passes just above the pubis and entirely below the abdomen, so that the abdomen is sustained upward, instead of being, as in most instruments, pressed downward. There are two pieces or levers passing up the back, not over the spine, but each side of it, so that it is firmly held from lateral deviations. At the top is a

cross-piece, in the form of two T's, with the small ends united. The object of this arrangement is that the straps may pass directly forward and around the arms, and thus prevent a great loss of force by diagonal action; and also that they shall touch the person only where the pressure is needed, namely, on the forward part of the shoulders. This arrangement entirely obviates the painful and dangerous ligaturing of the arms which would occur if the straps passed forward from one point." (This object may be still further promoted by making the lower arms of this scapular or cross-piece spread outward until they reach the line of the axilla. I usually direct it to be made twice as wide at the bottom as at the top, thus producing no lateral pressure whatever, and removing all danger of abrasion in the axilla.) "At a part of the instrument opposite the seat of disease, the point where we make our fulcrum, the pads are placed. These pads are very important. They are made of chamois-skin or Canton flannel, and are filled, not with cotton, which soon packs and becomes hard, but with long, elastic African or East India wool, which has no felting qualities.

"These pads are not permanently attached to the instrument, but are made separate so that they can be removed as often as they become at all compacted. The shoulder-straps and the band around the hips are likewise provided with similar removable pads to protect the skin from

pressure and abrasion. It will thus be seen that the instrument, like the spine itself, acts like a double lever with a common fulcrum at the curvature; this action is directly backward at the hips and shoulders, and directly forward at the middle of the back, or wherever the diseased part is located. Thus the posterior portion, the only healthy portion of the diseased vertebra, is made to support a part of the weight of the body, and the intervertebral cartilage and bodies of the vertebræ, where the disease exists, are relieved of pressure. . . . The instrument is provided with several hinges, stop hinges in front but free to bend backward, which allows the most unrestrained use of the muscles of the back. Whenever the spinal muscles are brought into action, instead of acting against unyielding resistance, the instrument bends freely backward, thus stimulating and encouraging muscular action, as the patient, when free to do so, involuntarily makes frequent effort to gain momentary relief from the instrument by attempting to straighten himself up. Indeed, the spinal muscles, by alternate action and rest, actually alternate with the instrument in sustaining the weight of the body and overcoming the curvature. It has proved to be useful in causing the development of the spinal muscles instead of binding them up and causing their atrophy, as results from the use of instruments which prevent muscular action."

In this last-mentioned respect, Dr. Taylor's in-

strument goes a step in advance of Dr. Davis's proposed plan of treatment. The latter says, it will be remembered, "the apparatus should confine the parts *quite immovably* in their normal position, and retain them there until recovery has taken place;" thus making no provision for the exercise and development of these important accessories. I have seen a back that was almost bare of muscular tissue, in consequence of the wasting strain produced by the deformed position of the trunk, become quite well developed in the course of a few months under the simple use of this instrument.

The uprights or levers, described above by Dr. Taylor, should be made of steel, sufficiently strong to sustain the entire weight of the trunk, and thus resist completely any effort, voluntary or involuntary, at flexion anteriorly, while at the same time they should be of such temper that the physician can, if furnished with the proper appliances, bend them to suit the varying requirements of the case. Above all things, they should not be—what every instrument-maker is most desirous to make them—elastic. "Spring," as they call it, is the very last quality to be sought in a spinal splint. In the treatment of this disease there can be no compromise. The instrument which fails to give complete support had better not be worn, as it will only embarrass and annoy the patient by its weight. It may seem a paradox, but it is nevertheless true, that, after reducing the weight to a certain point, every

ounce taken off from the effective part of an instrument only makes it so much the heavier. As long as the spine is well supported at the seat of disease, the weight of the instrument is unnoticed ; but as soon as an irrational desire for lightness and beauty diminishes the strength of the latter below the point of due resistance, it at once becomes an annoyance, and the less efficient the support the greater is the intolerance of it. Each upright is usually furnished with two hinges, as described by Dr. Taylor, and the portion between these hinges being made wider and lighter than the rest, forms the pad-plate. Immediately beyond each hinge is a screw passing through the upright and pressing against the pad-plate. This renders the instrument capable of the nicest adjustment, the pressure of the pad being regulated by these screws. While these screws afford a most admirable means of adjusting the instrument with little trouble, and without removal from the person, they are, however, open to the objection of weakening the uprights at their points of penetration. To compensate for this local weakness, the entire instrument must be made stronger, and therefore heavier. Where a patient is very young or very weak, this increase of weight is a decided objection. To obviate this, I have devised the following mechanism : For the two screws I substitute two very thin steel or brass slides, one end of each of which is welded around a piece of wire, thus forming a wedge. These slides pass

under the hinges, and are retained in place by a fine screw penetrating the centre of the pad-plate, up and down which they play by means of a slot. Now, it is obvious that the wedge being drawn between the pad-plate and the upright will increase the pressure of the former at either end as may be desired, and that the nearer it is approached to the hinge the greater will be the increase of pressure. If it is desired to limit the pressure to a certain degree, as in the case of lordosis, I cause the upright to pass through the free end of the slide, and place a small button on the under side of the latter, which, working in a slot in the pad-plate, effectually controls it. Support is afforded to the usually distended and pendulous abdominal walls by an apron attached below to the strap of the hip-band, and buckling to the uprights behind. Where it appears desirable, this apron may be carried sufficiently high to exert a moderate amount of pressure on the projecting sternum and thorax anteriorly. Care must be taken, however, not to embarrass respiration.)

The instrument is seen applied in Fig. 6, which is copied from a photograph of

CASE I.—Joseph Armstrong, of Pottsville, Pa., July 21st, 1865, æt. 17 years. Began to work in the mines when quite a small boy. Had a "hard boss," and was obliged to lift heavy weights. Afterwards worked in a foundry, where also he had much severe lifting to do. About four years

since, discovered a small projection of the spine about the middle of the back, and very soon after found that he was losing strength. At this time he began to suffer from pain in the right side and hip, and to be unsteady in his gait, frequently

Fig. 6.



falling. During the first six months, was subject to "cramping pains" in the stomach and bowels, at one time lasting a week and confining him to the bed. The deformity steadily progressed, and his general health became more and more impaired,

until the third year of the disease. He then came to Philadelphia and consulted a distinguished surgeon. By his advice he went to one of the first instrument-makers of the city, who provided him with a brace of the ordinary construction. This gave him so much pain that he was able to wear it only four weeks, during which time he experienced no relief whatever from its use. Since then, a period of nearly a year, his condition has continued to grow worse.

Present Condition.—Face anæmic, considerable emaciation ; is very feeble, not being able to walk a square without resting. Considerable dyspnœa and frequent palpitations. The four lower dorsal vertebræ form a curve of great prominence, which is complicated by an extreme lateral deviation to the right. He walks much bent, with the right hand resting on the knee. Habitual position when at rest, the chest supported on the seat of a chair, while the knees are braced against the round.

I applied the splint at the above date. The accompanying cut is after a photograph taken six months later, in January of the present year. At that time he expressed himself as rapidly gaining strength. Had a good appetite ; could walk a mile ; his carriage was so erect that his old friends often passed him in the street without recognizing him. The lateral curvature was almost entirely corrected. Color better. Is gaining flesh. Suffers from neuralgic pains in both legs, more severe in

the right. This has been a troublesome complication of the case, but is diminishing. The palpitations have ceased entirely. He now feels himself so far restored that he has opened a small store.

When the cervical vertebræ are the seat of disease, it becomes necessary to find a point above the level of the shoulders against which to exert pressure anteriorly. The only available point for this purpose is the chin. To reach it, the following modification of the instrument is necessary. The scapular is made with lower arms only, and the straps are attached above at the angle where the arms are given off. In the centre of the scapular is placed a keeper, for the reception of an upright which carries the occipital bow. This upright is three or four inches in length, and furnished with holes which, corresponding with a hole in the centre of the keeper, enable it to be securely fastened by a screw at any desired height. The occipital bow, covered with silk or velvet, and slightly padded, passes up under the *occiput* to a point a little above or below the level of the ears on either side, and is armed at its extremities with two small hooks or flat rotating buttons. Unless the atlas and axis are supposed to be involved in the disease, this piece rotates on the upright, thus giving ease and freedom of motion to the head; but if that be the case, all lateral motion should be avoided, for fear of rupture of the lateral liga-

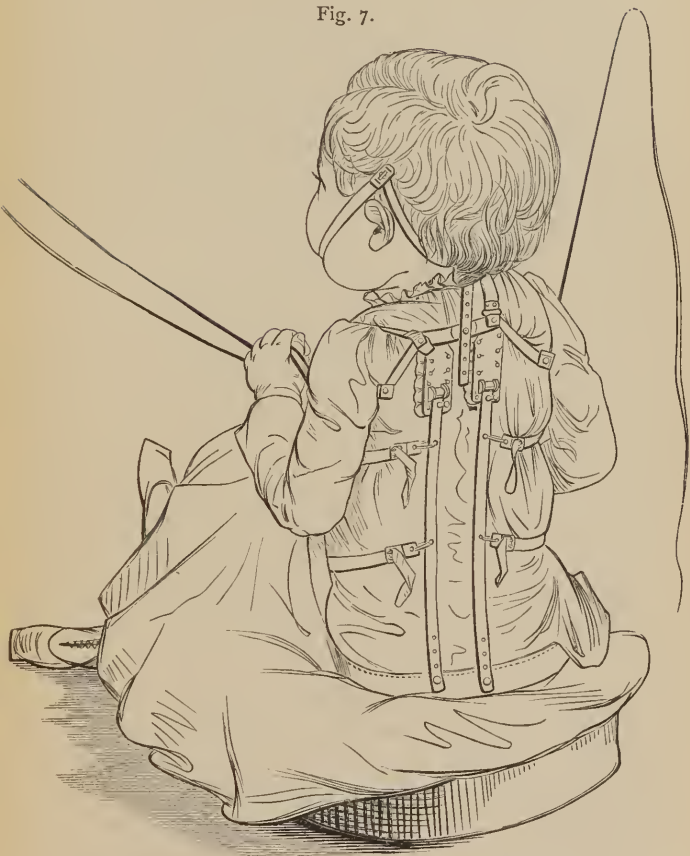
ments, possibly weakened by ulceration. The chin-piece may be either a leather strap or a light steel band, covered and padded where it makes pressure, and with an opening in the middle to receive the point of the chin. At either end of the strap are eyelet holes, or if the steel band be used, several narrow transverse openings, to admit the button on the occipital piece, which, being turned, makes it perfectly firm. I prefer the latter, as it can be made narrower than the leather, is more secure, and does not compress the cheeks so much.

The little fellow from whom the drawing on page 41 was made presents the following history:

CASE II.—C. W. H., seen in consultation with Dr. S. Weir Mitchell, September 9th, 1865, native of Philadelphia, æt. 2 years 9 months. At birth was considered by the attending physician to be hydrocephalic. This tendency rapidly developed until, at the age of six months, the head had become very large, and there was evidently water on the brain. For several months his life was despaired of. From this condition, however, he at last began slowly to recover until his health became tolerably good. At the age of eighteen months, he fell to the floor from a high counter in his father's store, striking the back of the head and upper part of the spine. Toward the end of the second month after this fall, his mother observed that he seemed to suffer on being moved, so that

soon every attempt to lift him, especially the movements incident to dressing and undressing, caused immediate and violent fits of screaming. His mother writes: "If laid upon his back, he seemed to suffer most intense agony,—he was very restless at night, lifting his head and letting it fall again as if too heavy for the spine to bear, and crying out very often. Indeed, we never had a good night's sleep until he began to wear your instrument." He made no attempt at walking until he was two years old, and then very feebly, stooping at the hips and dragging the feet. About two months later, it was noticed that he held his head stiffly, and used his right arm very awkwardly. In the course of six or eight weeks from this time, a prominence of the spine was observed for the first time just above the level of the shoulders. By the advice of a female hydropathist he was "packed!" for the space of about six weeks, with what amount of benefit may be imagined. He was then provided with an ordinary spinal brace, but still continued to grow worse. At the date of coming under my care his gait was extremely unsteady, his appetite irregular, his sleep disturbed, and his disposition excessively irritable. Paralysis of the lower limbs had evidently commenced, and before I could get an instrument made for him, he had entirely lost their use. The upper dorsal and two lower cervical vertebræ were affected, quite a prominence existing at that point, and the cervical column

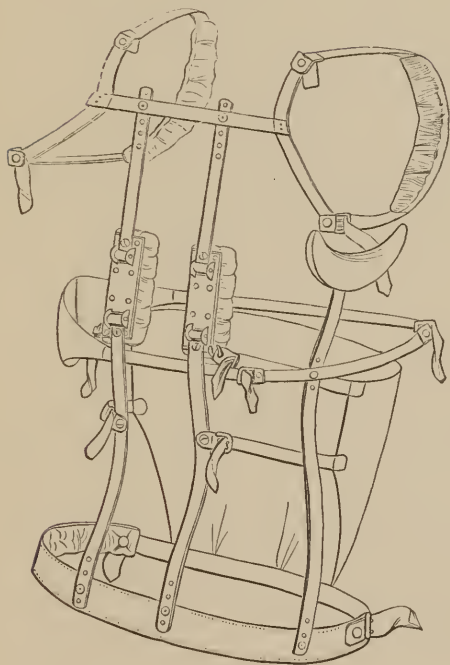
Fig. 7.



being directed forward at a sharp angle from it. Fig. 7 shows the instrument as worn by this patient. The improvement in his general health on its application was immediate and marked. He became cheerful, his nights restful, his appetite constant, and his movements, so far as the head and upper extremities were concerned, natural. The paralysis of the lower limbs is slowly passing off. Dependent, as I believe it to be, not on compression of the cord, but on meningeal congestion or inflammation, it is not to be expected that it should diminish *pari passu* with the improvement in other respects. (The further progress of this case will be found detailed in the paper on "Suspension" as Case No. 1.)

The lateral deviation which accompanies many antero-posterior curvatures differs from true lateral curvature in the fact that it is rarely associated with rotation of the bodies of the vertebræ. It is a simple yielding to one side, probably on account of the greater relative destruction of the corresponding side of the affected vertebra, or, it may be, of the ligaments of the opposite side. It usually begins to improve very soon under the application of antero-posterior force, and often disappears entirely without any other appliance. Its presence, however, of course necessitates a greater degree of pressure upon the opposite side of the vertebral prominence, and for the relief of this, as well as to hasten, in some cases, the restora-

Fig. 8.



tion to the erect posture, I sometimes add to the instrument the contrivance depicted in Fig. 8.

It consists of a firm steel upright having a broad padded crescentic top, and provided with a cross-piece. The upright is riveted to the hip-band on the side toward which the trunk yields, at a point immediately under the centre of the axilla,

and is of such length that its upper crescentic border touches the axilla without making any upward pressure, the action being purely lateral. The cross-piece is riveted to the upright at a point a little below the seat of greatest curvature, and extends horizontally until it reaches the anterior and posterior planes of the body. A broad rhomboid binder, stiffened in its vertical diameter by a thin whalebone, passes around the convexity of the opposite side, and buckles by straps to either end of the cross-piece. A simple lateral force is thus exerted without compression of the thorax, usually contributing much to the comfort of the patient as well as to the removal of the deformity.

CASE III.—Miss A. K., æt. 13 years, was placed under my care by Dr. J. T. Carpenter, of Pottsville, Pa., in March, 1865. Rather more than three years before, her gait became stiff and peculiar, her strength notably diminished, and she evinced a constant desire for extraneous support by leaning against articles of furniture. Before long a slight prominence was discovered in the lower part of the back, and in a few weeks she began to suffer pain in both legs, especially the right, and to have cramps in the spinal muscles.

The deformity progressed steadily though not rapidly, the general health slowly deteriorating until she became quite feeble and emaciated. At the time I first saw her, the spine presented a large irregular curve, involving the five lower dorsal

vertebræ, with considerable tendency to lordosis, and extreme lateral deflection to the right. She walked habitually with the right hand resting on the right thigh, or dragging down her dress from the hips with both hands in order to support the trunk and shoulders. She walked with difficulty, and could not go a rod without being compelled to sit down and rest. The application of the instrument afforded relief to the pain and difficulty of locomotion in a surprisingly short time, and her improvement has been constant ever since. To-day, January 27th, 1866, ten months after it was first put on, she has walked three miles in the course of the morning, without any very serious fatigue. She has a good appetite, healthy color, and is gaining flesh. Her gait is firm and comparatively natural, although the tendency to lordosis, which still exists, makes her a little more erect than is graceful. The lateral deviation yielded in a marked degree to the antero-posterior force, as usual, but only up to a certain point; and to keep it at this point required a great degree of pressure on the opposite side of the prominence. The lateral action was therefore added after she had been about six months under treatment, and has had the effect of still further remedying this phase of the deformity.

Dr. Taylor has recently suggested a modification of the instrument (Fig. 9) to meet the peculiar deformity known as lordosis, referred to in the case

Fig. 9.



above related. This consists in dispensing with the lower hinge, and causing the lower lever to fit in directly under the projecting shelf formed by the spine and ribs, following closely the curve of the lumbar column, except just at its centre. Instead of a small pad-plate just at the seat of disease, the lower lever is provided for its entire length with a thin steel plate, which is well padded. The pressure is thus made upward as well as forward at the point of projection, and the tendency is to open out this secondary curve, as if by a wedge.

Whatever be the nature of the deformity, and whatever the modification of the instrument, it is essential that the latter should be kept acting forcibly in order to be of any service. If worn loosely, it fails of its object, and is simply burdensome. To this end, the pressure of the pads must be considerable, and much care is therefore requisite to keep the skin underneath them in a healthy condition. The danger is not of simple excoriation, but of that diminution of the vitality of the skin, which results in passive congestion and solution of continuity from simple disorganization, and which, when it affects the deeper-seated tissues, has received the name of bed-sore. To guard against this result, parts subject to pressure should, at least once daily, be carefully bathed in cool water. Friction of the surface and kneading of the deeper tissues with the fingers should be employed to promote the capillary circulation and stimulate the sentient nerves, and applications of astringent solutions should be made with a view to hardening the integuments. If an ulcer be formed, it should be coated daily with a mixture of collodion and castor oil, of which the prescription is subjoined.*

While to Dr. Davis belongs the credit of having first distinctly pointed out the anatomical fact which

* R.—Collodion, \bar{z} j;

Ol. ricini, \mathfrak{M} v. M.

S. Apply with a camel's-hair pencil.

enables us to treat successfully this most distressing malady, the fallacy of the prevailing style of apparatus, viz., that which relies for its action on counter-extension by transmitting the weight of the head and trunk from the axillæ to the pelvis, was long ago exposed by Prof. J. K. Mitchell, of the Jefferson Medical College of Philadelphia. In an editorial foot-note to Mr. Bampfield's prize essay *On the Curvatures and Diseases of the Spine*, already alluded to, and republished by him in this country, in 1845, he says: "I may here repeat that the axilla, being a movable point, affords no good means of support, and that there are many objections to throwing the weight of the head and shoulders on the pelvis." These objections he had alluded to nineteen years before in a communication which appeared in the first number of the *North American Medical and Surgical Journal*, asserting that this class of instruments "so bind down the muscles of the trunk, so compress the abdomen and chest as to be sometimes useless and often prejudicial." The plan of treatment which he adopted to avoid these difficulties, and which is fully described, with illustrations, in the article referred to, consisted of a revival, in a modified form, of the old method of suspension.

The apparatus may be found described, almost exactly, in the fourth volume of the *Mémoires de l'Académie Royale de Chirurgie de Paris*, in a contribution by M. Le Vacher, in the year 1768; the

difference between his mode and that of Prof. Mitchell being, that the former attached his mechanism to a corset, worn on the person, while the latter found his point of support altogether outside of the body, and was thus enabled to make use of the entire weight of the trunk and lower extremities (and in some cases even of the upper) as an extending force. In no other way can the principle of extension be made available. That it can be made available in this way, both in angular and lateral curvature, the very interesting and successful cases published by Prof. Mitchell sufficiently attest. It is difficult to conceive why so valuable a means, so well introduced and so ably supported, should have been allowed to fall into such complete disuse.

The medicinal treatment of this affection does not fairly come within the purpose of this paper, and, in fact, I have little to say of it save in the way of deprecation.

Suppurative counter-irritation is mentioned only to be condemned.

The gastric and ventral pains are not produced by worms, and therefore do not demand vermifuges. They are not dependent upon disease of the mucous membrane, either organic or functional, and therefore will not yield to bismuth, nitrate of silver, or the acids. They are probably the result of spasmodic contractions of the muscular coat of the stomach and intestines, and, like

all spasm, may be temporarily relieved by opiates, alone or combined with chloroform. In my experience the combination known as chlorodyne,* for which I append a prescription, is the most efficacious for soothing this distressing symptom, but nothing will permanently benefit it, except cessation of the central irritation.

The furred tongue, foul breath, deficient appetite, and other evidences of imperfect digestion which so often accompany true spinal disease do not invariably indicate, as they almost invariably receive, a course of tonics and stimulants. Gentle purgation, systematically followed up, will often be attended with the happiest results when the other plan has failed. When a medicinal tonic is evidently required, some combination of cinchona, iron, and phosphorus will be found to meet the indications most nearly. Phosphoric acid lemonade is a grateful beverage, and well calculated to supply waste both of bone and nerve. One tonic, however, may and should be administered very

* R.—Liq. morphinæ sulphatis (gr. j ad ʒj) ʒss;
Tinct. cannabis Indicæ (gr. ij ad ʒj), ʒj;
Syr. gum. acaciæ, ʒj;

Misce et adde

Chloroformi,

Spt. ether. sulph., āā ʒss;

Tinct. capsici,

Acidi hydrocyanici (dil.), āā ʒj. M.

S. From five to thirty drops in a little water.

freely—*open air*. Large doses of this invaluable remedy (the action of which is much heightened by the stimulus of the direct rays of the sun), in connection with a due regard to other hygienic precautions and efficient mechanical support, have usually sufficed, in my experience, to remove all the general symptoms without resorting to medication at all. When there are indications of acute inflammation in either the vertebræ or the meninges, the recumbent posture should be resorted to for a considerable portion of the time; and much good may also be accomplished by the daily application of the spinal ice-bag.

Such collateral or sequential affections as paralysis, psoas abscess, secondary abscess, etc., do not come within the scope of this essay. The first, however, I may be justified in alluding to, simply, as it has been made the ground of a severe, but unfounded, criticism upon the action of the instrument I have been describing. It consists in the suggestion of the possibility that the vertebræ may be separated with such rapidity at the seat of ulceration as to make a more or less wedge-shaped opening into the cavity of the spinal canal, into which the cord may protrude, and in the event of a temporary intermission of the use of the support, be subjected to compression between the ulcerated surfaces of the bodies, thus inducing paralysis. Those to whom this fear suggests itself should bear in mind the following facts,

which, taken together, render the occurrence of such an accident infinitely improbable, not to say impossible.

1st. That at least one-fourth of the spinal column is composed of highly elastic fibro-cartilage,—a portion of which is indeed mere pulp,—and that on the relief from superincumbent pressure, this elastic fourth portion would be the first to regain its normal position and consistence, and that, moreover, by virtue of its elasticity, expanding downward as well as upward, it would tend to retard this dreaded gaping open of the diseased vertebræ.

2d. That not the vertebral column alone, but the entire thorax, participates in the deformity, that the ribs are approximated one to another, and the thorax to the pelvis, and that the inter- and intra-costal and the powerful abdominal muscles, having become contracted from position, must first be stretched out to their normal length, along the whole anterior surface of the trunk, before the spine can become again erect.

3d. That in like manner the prevertebral muscles in the cervical, and the psoas masses in the lumbar region interpose to prevent this sudden, violent separation; and that the elastic anterior ligament is exerting a force in the same direction all the way down the front of the column.

4th. That nature, ever watchful, is ready to take advantage of the slightest opportunity for repair. Abhorring a *vacuum* as much in the interior of the

body as externally to it, as soon as she finds relief from the pressure under which the inflamed vertebræ have been rapidly melting away, she ceases to busy herself with absorbing and removing *detritus*, and makes an effort, not always successful, it is true, but generally so, at building up a new structure to take the place of that which has been destroyed, and thus fill up the chasm as fast as the elastic cartilages and slowly yielding muscles and ligaments permit it to be produced.

And, having thus considered the obstacles which nature interposes to the formation of this trap for the unsuspecting cord, let them recall the safeguards which surround that cord. It does not hang carelessly swinging in space, but is firmly stayed in its central position by the dentate ligaments which pass from its dense, closely-fitting tunic, the *pia mater*, out to the *dura mater* (itself protected exteriorly by a layer of adipose and a venous plexus), as well as by those prolongations of its own substance which constitute the roots of the spinal nerves; while the interspace is filled by the reduplicated *arachnoid*, by areolar tissue, and by several ounces of fluid. So complete is this protection, that deformity may go on to the utmost limit, the spine being bent even at a right angle, and yet no compression of the cord, as indicated by paralysis, shall take place.

This last-mentioned fact indeed constitutes the dangerous point of the criticism. The paralysis

which accompanies angular curvature is not, in ninety-five cases out of a hundred, caused by undue pressure of the bony envelope, but by inflammation or congestion of these membranous investments. This is proved by the fact that there is no relation whatever between the frequency of the occurrence of paralysis and the growth or degree of the distortion, the most horrible deformity taking place without disturbing in the least the function of locomotion in many cases, while in others, complete paralysis may supervene before there has been the slightest deviation from the normal curve; by the rational signs, which are those of meningitis, rather than of compression of the cord; and by the fact that recovery from paralysis is often seen, even while the deformity is on the increase. Nor, on the other hand, will a diminution of the vertical pressure at the seat of disease, or even of the deformity itself, necessarily prevent an extension of the inflammatory action from the osseous to the membranous tissue. Any case, therefore, even while being rationally and successfully treated, is liable to an access of paralysis. How unwarrantable to attribute its occurrence to the mode of treatment! I feel that this question may safely be left to the candor of the profession, and dismiss it with the following quotation from Prof. Mitchell's paper already alluded to: "Where there is advantage to be derived from machines, I use them without much regard to such theoretical objections."

II.

MODIFIED SUSPENSION.

From the Transactions of the Medical Society of the State of
Pennsylvania for the year 1870.

II.

MODIFIED SUSPENSION.

THERE is no single characteristic of the human form which more entirely commands our admiration, and more strikingly distinguishes it from those of the various families of the brute creation, than its erectness. So universally is this fact recognized, that it has been incorporated into our language. Considering an erect carriage and a well-poised head as an index, and hence a type, of a perfect physical organization, we, in common with the Germans, have carried the idea into the domain of ethics, and designate the individual who exhibits, in his dealing with his fellows, a healthy and undistorted moral nature, an *upright* man.

It is to the spinal column, and its mode of articulation with the pelvis and the head, that this noble peculiarity of our race is due. Any diseased action in either the essential or accessory constituents of this important organ must sooner or later result in the impairment of this distinguishing feature. Three deductions have been

made from this well-understood fact, which have been shared, at different times to varying degrees, by the medical profession and the general public.

1. That a loss of erectness of figure, as a rule, indicates spinal distortion, and hence diseased action in either the spine or its motor apparatus.

2. That the distortion is not only an indication, but an actual element, of the disease, directly tending to aggravate and perpetuate the morbid conditions; and hence,

3. That a restoration of the distorted spine to or towards its normal position is an important means of checking the destructive processes and restoring it also to a healthy state.

It is on this last proposition that the mechanical treatment of spinal distortions is rationally founded. Two methods of effecting the result which it contemplates early suggested themselves. They may be designated as the *method of counter-extension* and the *method of counter-pressure*,—the first being an effort to straighten out the curved spine by traction in the line of its axis, acting in opposite directions from its two extremities; the second, to unbend the curve by forces applied at right angles to the line of its axis,—in one direction at its two extremities, and in the opposite direction against its point of greatest convexity. Both methods may be practically carried out in two ways: either by means of apparatus worn upon the person, indifferently called braces, supporters, assistants,

splints, etc., which I shall designate as *spinal instruments*, or through the medium of apparatus acting from some fixed point of support outside of the person, which I shall call *spinal machines*. I have already assigned my reasons for believing that spinal instruments should be made only on the principle of counter-pressure. My object now is to indicate the perfect applicability of the principle of counter-extension to the construction of spinal machines, and to call attention to the rapid and admirable results attainable by its means.

I am well aware that for years past it has been the fashion for medical men to decry extension of the spine by machinery as unscientific and dangerous, those who write with special reference to these affections treating it with contemptuous ridicule, while systematic authors entirely ignore it. It has had powerful advocates, however, on both sides of the water. Among the more important in England may be mentioned Darwin,* Shaw,† and Sheldrake,‡ and, in this country, Kissam, of New York, and Prof. Mitchell,§ of this city, the latter of whom,

* *Zoönomia*, or the Laws of Organic Life. By Erasmus Darwin. Vol. iii. p. 140 *et seq.*

† *Observations on the Causes and Early Symptoms of Defects in the Form of the Spine, Chest, and Shoulders.* By John Shaw. London, 1827.

‡ *A Treatise on Diseased Spine and on Distorted Spine, with Cases to illustrate the Success of a New Method of Cure.* London, 1816.

§ *North American Medical and Surgical Journal*, No. 1, 1826.

with that carelessness of purely theoretical criticism which characterized the man, was particularly enthusiastic in its support, and, I may add, as successful in its employment. A surgeon of many years' standing in the navy of the United States is a living monument to the admirable results which that physician obtained by this means in cases of spinal caries.

The plan which he adopted was the seemingly rather severe one of suspension by the head in the erect posture, the weight of a portion of the trunk and of the lower extremities being the extending force. This differed altogether from that of Shaw, who placed his patient in a recumbent posture and applied traction at the head and pelvis, and, to a considerable extent, from those of Darwin and Sheldrake, who, though they relied upon the weight of the body for their force, had their patient supported upon an inclined plane. Nevertheless, the idea was not a new one with him, by any means; for we find Bampffield saying that "in the erect state of the body the spine can be stretched by swinging by the head or by the hands," and that, "if it be the intention to stretch the upper half of the spinal column, swinging by the head will more particularly effect it, whilst the weight of the lower extremities will also extend the lower vertebræ in some degree." The portion of the appliance which Dr. Mitchell used, which was claimed by him as his own idea, as I understand

it, was the *go-cart* provided with the means of suspension, which had for its object the conjunction of locomotion with extension, and which he termed, appropriately enough, his "spine-car." It is to this plan of extension by partial or complete suspension in the vertical position, whether in the standing or sitting posture, that I desire for a few moments to call the attention of the society. And, first, I wish to point out certain weak points in the treatment of spinal caries by counter-pressure in which I consider that it is most advantageously supplemented by this method. Our avowed object in making use of antero-posterior force in a horizontal plane is to substitute the oblique articulating processes, in great measure, for the vertebral bodies at the seat of disease, as the axis of support for the weight of the head and trunk. Now, while it is true that these processes are of comparatively firm texture, and almost invariably free from disease, it is also certain that the constant endurance of a weight so much greater than that which nature intended them to bear must be attended, in time, with a certain amount of absorption of their tissue. Besides this, their opposing surfaces are so oblique that much of the weight will necessarily fall upon their ligaments, which must become more or less relaxed, and thus permit the processes to slip by one another, distorting the articulation, and diminishing the height of the patient. This is one unfortunate result of this

method. The other consists in the fact that we have no means of determining at what point in the column, intermediate between our opposing forces, either above or below the seat of the projection, the pressure applied against the spine in an anterior direction shall cease to exert its force. Theoretically, it should do so just where the abnormal projection meets the normal line of the column. But if there happen to be a weaker point than this, the force will be transmitted to that point, and we shall have an incurvation produced which, when below the projection, assumes the very troublesome form known as *lordosis*. This is a second evil, which can neither be prevented nor corrected by apparatus worn upon the person. But I think it will be acknowledged that extension by suspension—taking off this destructively abnormal weight from the processes, and gently stretching out the consecutive curve—is admirably adapted to palliate, if not to entirely remove, these difficulties.

Again, the degree of pressure which we are compelled to make use of in redressing the curve is sometimes so great as to provoke a superficial abrasion of the cuticle. This is especially apt to be the case in warm weather. Other causes, too, may render the surface intolerant of pressure, such as abscess, the use (or abuse) of setons, issues, moxas, *et id omne genus*, hyperæsthesia of the integuments, and eruptions. Under such circumstances, modified suspension furnishes an admir-

able substitute for instrumental support for a sufficient length of time daily to give an opportunity for reparation of the surface. It is also especially adapted to caries in the cervical region, affording the patient the most complete and delightful relief from the agonizing pain or wearisome discomfort which the weight of the head gives rise to, and accomplishing much for the restoration of the deformity.

I present, for the inspection of the society, three different pieces of apparatus, or machines, in which this principle is applied. And, in order that members may the better appreciate the mode of application, and the entire ease with which they are used, some of my patients who have been treated in this manner have kindly consented to be present and allow me to demonstrate their action with their assistance.

CASE I.—The little patient whom I now introduce to you is 7 years old, rather short of stature, as you see, but ruddy and well nourished, having the complete use of his limbs, walking freely, fearlessly, and naturally. When he first came under my care, five years since, he was completely paralyzed in the muscles of the lower extremities and, to a great extent, in those of the trunk, as indicated by inability to move even the terminal phalanges of the toes, or to maintain the sitting posture. His condition was, in fact, altogether a critical one.

The cervical portion of the spine being the seat of caries, and two vertebræ having been, to a considerable extent, destroyed, the head was tilted back until the occiput rested on the shoulders, and so firmly that it was impossible to insert the finger beneath it, while the skin of this region was acquiring that moist, mucoid character often noticed when cutaneous surfaces are kept in constant apposition. He suffered from constant dyspnœa, respiration being to a great degree diaphragmatic; had frequent attacks of spasmodic gastralgia; was greatly emaciated; passed sleepless nights; and was, as may be imagined, excessively irritable, allowing his mother and nurse not a moment's ease. The application of a splint, provided with a head-piece for producing erection of the cervical spine by means of antero-posterior force, very soon relieved all his most pressing symptoms, but it was some months before he acquired sufficient muscular power in the legs to be able to move the toes. At this time my attention was called by Dr. S. Weir Mitchell, in consultation with whom I first saw the case, to his father's experiments and successes in the employment of suspension. Although greatly prejudiced against its use, I felt that at least no injury could ensue if it were employed with proper precautions, and determined to give it a fair trial, considering that a desperate case justified what I then viewed as a desperate remedy. I therefore had made for him this steel rod, bent at

right angles and provided at its lower end, for a distance of about eight inches, as you see, with ratchet teeth on one side. The horizontal portion of this rod, carrying a steel bow, to which the chin and occipital strap could be attached, passes over the head, while the vertical serrated portion is received into a keeper screwed to the back of the little chair in which he ordinarily sat. The straps being adjusted to the head, I am enabled, by means of a pinion-key introduced at the back of the keeper, to elevate the rod, and thus extend the cervical spine at will. Conscious of relief, from the complete removal of the weight of the head from the ulcerated and sensitive vertebræ, the little fellow, to my surprise, became at once reconciled to so singular a position, and even enjoyed it. The paralysis now began to diminish with notably increased rapidity, so that he was soon able to sit alone, and could move the legs slightly. With a view to give him an opportunity of exercising these reawakened muscles, and of associating amusement with the necessary confinement, I therefore had a little rocker constructed upon which his chair could be fastened. This you now see before you. Placing him upon it, adjusting the straps, and making extension, you see how completely the head is supported, and yet with what freedom and fearlessness he rides, turning his head from side to side at pleasure, and bringing almost all the muscles of the trunk and lower extremities into active, though

gentle, play. This amused him, and he often spent two or three hours a day upon it, with the effect of greatly increasing his muscular power. He was still, however, unable to walk. In order to teach him to stand and to encourage the natural movements of the legs, I then had this car or perambulator constructed (simply the child's go-cart, formerly so much in vogue for infants learning to walk), with a keeper attached to it posteriorly to receive the ratchet-rod. In this he was at once able to stand up without risk of falling, and soon began to take steps. The paralysis being completely relieved, the general health restored, and the position of the head greatly improved, his mother's anxiety was now aroused with regard to that inevitable accompaniment of carious destruction of cervical vertebræ,—distortion of the thorax anteriorly, and projection of the lower end of the sternum, unquestionably a very unseemly and distressing phase of the deformity. To remedy this defect as far as possible, by bringing the pectoral and other muscles of the thorax into action at the same time that spinal extension was being carried on, I devised—partly in imitation of Dr. Mitchell, and partly acting on a hint contained in a little German work on the “Treatment of Deformities by Curative Gymnastics,” by Dr. Nitsche, director of the “Orthopædeon” at Dresden—the *spinal swing*, a specimen of which I have caused to be erected here for your inspection. The contrivance

Fig. 10.



for the support of the head is the same as in the other machine, viz., the steel bow with the double strap for the chin and occiput, in which the head is exactly balanced. But the elevating apparatus is now entirely different. Instead of the ratchet-rod, we have a stout cord or rope, and in place of a key and spring as an extending force, the patient's own hands and strength of arm. It is not necessary to have a frame constructed like this before you. A pulley may be firmly attached to a joist in the ceiling or over a doorway; the former is preferable, as giving greater length of rope, and, therefore, more freedom and variety of motion. Over this pulley passes the rope. One end of it is firmly attached to the steel bow over the top of the head; the other hangs down in front of the patient's face, and is provided with two movable ovoid blocks, which, sliding on the rope, serve as handles. These are placed from three to five inches apart, according to the size of the patient, and retained in position by a knot under each. The lower one should be about on a level with the top of the patient's head. Now, it is evident that, the head-straps being applied, as soon as the patient makes traction upon the rope by means of the handles the force is transmitted over the pulley directly to the head, which is thus drawn upward, and that the weight is equally shared by the head and the hands; so that, when the feet are raised from the floor, just one-half the patient's weight,

less that of the head, is supported by the cervical spine. It is also plain that, when the disease is below the line of attachment of the arm to the trunk, the entire weight of the body below that point will be our extending force. The apparatus being under the patient's control, however, it is optional with him what amount of force he shall make use of. In the case of children, it is oftener necessary to caution them against using too much than to urge to use more. You see this little fellow gradually drawing himself up on his tiptoes, and now actually lifting his feet and allowing me to swing him back and forth, not only without pain, but with positive enjoyment. Under the use of this machine for from one to two hours a day, there has been a gradual amelioration of the thoracic distortion, the ribs assuming a more natural position, and the sternum falling more towards its normal inclination, while the general capacity of the chest has increased. A tendency to chronic and occasionally acute pulmonary catarrh, which more than once threatened to prove fatal, and which I was inclined to attribute in part, at least, to the compressed condition of the lungs, has also almost entirely disappeared.

CASE II.—The young girl whom I now bring before you has been under my care since September last. She is 17 years of age. Her parents are both living. The father suffers from chronic

rheumatism, but I am not able to discover any history of strumous antecedents. About a year before her physician called me to see her, her health having been previously all that could be desired, she began to suffer from pain in the back. This increased steadily, and in about six weeks wandering pains began to develop themselves in the head, radiating from the temples. Before long she observed that, after sitting for any length of time, she became stiff and could walk only with considerable difficulty. So great was this rigidity on rising in the morning, that it took at least two hours for her muscles (the flexors of the thigh more particularly) to become sufficiently relaxed to enable her to walk with any comfort. She grew steadily worse all winter, and early the next summer was obliged to give up her trade, which was that of envelope-folding, in consequence of the frequent falls which she had when walking in the street. These falls were caused by a sudden spasmodic contraction of certain of the flexor muscles of the thigh (principally the psoas and piriform, presumably) of the left side, accompanied by excruciating pain in the hip. This pain and spasm also often attacked her during sleep, causing her to wake with a scream. By this time the headache had become very severe, and was often attended by obstinate vomiting. When I first saw her it was almost constant, as well as the pain in the hip already referred to. She was much emaci-

ated, without appetite, not able to stand erect, or to walk across the room unassisted. Her physician had run through the whole list of anodynes without succeeding in relieving the pains, and greatly to the disgust of her stomach. I felt not the slightest doubt, from the symptoms, history, and attitude of the patient, that there was serious inflammatory, and probably ulcerative, disease going on in the spinal column; but it was impossible to discover its seat, no projection of a spinous process having yet taken place. From the absence of gastralgia, I concluded that it was below the dorsal region, and from the intense pain in the hip, that it was quite low in the lumbar region. I suggested to her physician that, the location of the diseased action not being positively indicated, it would be well to wait a short time before applying anything in the shape of a brace, and meanwhile to give what relief we could by the use of suspension. Accordingly, I caused a spinal swing to be put up directly over the couch on which she lay, and directed her to use it three times a day for ten minutes, gradually increasing the time as she became accustomed to it. This she did very rapidly, owing to the agreeable sensation of rest which the act of extension gave her. By the end of a week I was rejoiced to find her almost free from pain, with no vomiting, and quite a creditable appetite. The rigidity of the limbs was diminishing, and she could walk with some

ease. By the end of the third week, however, I felt confident that I could detect a slight bulging of the last lumbar vertebra, and at once ordered a splint to be made, to give support in that region. In a week from this time she walked to my office and back, a distance of half a mile, in order to have it applied. Her improvement was now so rapid that at the end of three months she resumed work for half a day, and for the past four or five months has been working her full time, although somewhat against my advice. During the winter she has once even ventured to go to a ball and indulge her terpsichorean tastes. Her menses, which were suspended for several months, returned soon after the application of the splint. She continues to use the swing, and, as you see, although quite heavy, is not afraid to bear her weight strongly upon the head-straps. She generally uses it, however, in the sitting posture, with weights attached, in order that she may be able to employ her hands. I do not need to say anything as to her present condition. Her firm, elastic step, rosy cheek, and bright eye, testify plainly enough what her general health is. Her treatment, I may add, has been purely mechanical, no internal remedies having been used.

CASE III.—This lad, the last case which I shall detain you to see, is fourteen years old. I first saw him in November last. He was then lying

about the house, good for nothing, pale and anæmic, and—having been obliged to give up going to school, in which he was much interested—very despondent. He complained of headache, pain in the hips, running down one limb to the knee, morning rigidity, and exhaustion on walking a very short distance, so that he could not go a square without stopping to sit down to rest. In this case, also, not a trace of posterior deviation existed; but, upon causing him to stoop forward, a slight yielding towards the left appeared in the upper part of the lumbar region. Profiting by my experience in the last case, which was then just beginning to feel the benefit of the brace, I determined to give him support at once,—not emulating the caution of the practitioner of whom I recently heard, who, when consulted in a case of suspected spinal disease, gravely informed the anxious mother that it might be necessary to wait two years before it could be determined whether such were the case or not. A spinal swing was put up for him the next day, and so rapid was his improvement that in a week he was able to walk to my office, a full half-mile, to have his splint applied. In three months he was at school again, and has recently obtained my permission to play base-ball. He also, as you see, has no fear of hanging, if allowed to be his own executioner. This case is one of the deepest interest, from the gratifying fact that not a particle of deformity has

made its appearance. I hold that the success of the treatment fully substantiates the correctness of the diagnosis, and that this boy is another living witness to the truth of the principle for which I have long contended—that inflammation of the spinal column is perfectly recognizable before it has reached the stage of caries and deformity, which evils may therefore, under favoring circumstances, be entirely averted. That it requires no education as a specialist to make the diagnosis in such cases, is sufficiently proven by the fact that the physician in whose practice these two very interesting cases occurred had in both instances become reasonably well convinced of the true nature of the disease before soliciting my assistance.

This mode of treatment is equally applicable to lateral curvature. In the incipiency of that affection, indeed, it may unaided be adequate to work a cure. By causing the patient habitually to take hold of the higher handle with the hand corresponding to the depressed shoulder, that shoulder is thus, for the time being, elevated and its muscles thrown into more powerful action than those of the opposite side, while the curve of the spinal column, if not too rigid, is entirely reversed, and, under any circumstances, diminished.

The advantages of the mechanical treatment in such affections, judiciously combining the use of

instruments and machines, over that which consists in confinement to the horizontal posture and the establishment of exhausting purulent discharges, are incalculable. While it is, to say the very least, *as* successful in preventing and controlling deformity, it affords to constitutions which so pressingly demand them, those sovereign tonics, *exercise* and the *open air*.

THE DIFFERENTIAL DIAGNOSIS OF SPINAL ARTHRO-CHONDRITIS,

DISEASE.	SEAT OF PAIN.	CHARACTER OF PAIN.	IMMEDIATE CAUSE OF PAIN.	EPIGASTRIC TENDERNES.	MORNING RIGIDITY WITH STOOPING
SPINAL ARTHRO-CHONDRITIS .	Radiating from epigastrium or in one side	Paroxysmal; spasmodic; excruciating; often nocturnal	Motion; shock; muscular contraction	Absent	Always present
GASTRODYNIA	Epigastrium	Paroxysmal; spasmodic; acute	Exhaustion	Absent	Absent
GASTRITIS (chronic) . . .	Epigastrium	Acute; not paroxysmal	Prehension of food	Always present	Absent
WORMS (in alimentary canal) .	Upper abdomen	Paroxysmal; spasmodic; acute	Not assigned	Frequent	Absent
ULCER OF STOMACH . . .	Epigastrium; ensiform cartilage and back	Paroxysmal; acute	Prehension of food	Always present	Absent
CANCER OF STOMACH . . .	Epigastrium	Dull or lancinating	Prehension of food	Always present	Absent
LEAD COLIC	Umbilicus or epigastrium	Paroxysmal; spasmodic; acute	Not assigned	Always present	Absent
HIP DISEASE (early stage) . .	Knee; front of thigh	Paroxysmal; spasmodic; excruciating; nocturnal exacerbations	Motion; shock; muscular contraction	Absent	Always present
SPINAL RHEUMATISM (chronic) .	Back	Constant; dull	Motion	Absent	Rare
LATERAL CURVATURE OF SPINE .	Rare; back	Dull	Fatigue	Absent	Absent
SPINAL IRRITATION (so called) .	Back and abdomen	Constant; dull	Not assigned	Frequent	Absent

THE INITIAL STAGE OF ANGULAR CURVATURE.—*In Tabular Form.*

MUSCULAR SPASM.	MUSCULAR CONTRACTIONS OF LOWER EXTREMITIES.	TUMID ABDOMEN.	LABORED OR JERKING RESPIRATION.	PARALYSIS.	VOMITING.	DIARRHŒA.	CONSTIPATION.	USUAL LIMIT OF AGE.
Local; always present	Not symmetrical; inverting foot; always present	Very constant.	Usual; often hic-cough	Common; asymmetrical	Rare; of food	Rare	Rare except with paralysis	Below 12
General; frequent	Absent	Absent	Absent	Absent	Absent	Absent	Frequent	Above 35
Absent	Absent	Absent	Absent	Absent	Frequent; of glairy mucus	Frequent	Rare	None
General; frequent	Not symmetrical; rare	Constant	Absent	Rare; usually symmetrical	Rare	Rare	Frequent	Below 12
Absent	Absent	Absent	Absent	Absent	Always present; often bloody	Frequent stools; black	Rare	Above 16
Absent	Absent	Absent	Absent	Absent	Always present; sometimes bloody	Frequent stools; black	Rare	Above 35
General; frequent	Absent	Absent	Absent	Frequent; commencing at wrist	Absent	Absent	Invariable	None
Local; always present	Not symmetrical; evert-ing foot; always present	Absent	Absent	Absent	Absent	Absent	Absent	Below 12
Absent	Not symmetrical; frequent	Absent	Absent	Absent	Absent	Absent	Absent	None
Absent	Very rare	Absent	Absent	Absent	Absent	Absent	Frequent	From 12 to 18
General; frequent	Symmetrical; occasional	Rare	Rare	Frequent; usually symmetrical	Frequent	Rare	Frequent	Above 14

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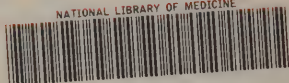
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